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THE STRUCTURE OF THE UNIVERSE[1]

THE phrase, "the structure of the universe," is apt to bring to mind only the great and majestic forms which are revealed to us by the telescope, the stars, nebulæ and galaxies. In the present discussion however I wish to include in one view the entire range of physical things from the infinitesimal to the infinite; for to the mathematician there is no such thing as absolute size—a thing is either large or small only by comparison.

Up to the present time we have succeeded in extending our vision equally, so to speak, in both directions. We find ourselves almost midway in a series of physical units. On the one side we have the electrons, atoms and molecules, and on the other we have the ordinary masses, stars and galaxies. The galaxies are more or less definite aggregations of stars. The stars are amazingly great organizations of hot gases. The gases in turn are resolved into their constituent molecules; the molecules yield up their atoms, and finally we find that the atoms are built up of two kinds of electrons. Each physical unit is analyzed into units of the next lower order, and synthesized into those of the next higher order. Each unit is an organization endowed with the proper amount of energy to carry on its existence and to insure its identity.

Our direct vision is bounded on the one side by the electrons and on the other side by the galaxies. But the common properties of energy and organization lead us naturally to imagine that the electrons in their turn are organizations of still smaller units, let us call them sub-electrons; and the sub-electrons are organizations of still smaller units, and so on, ad infinitum. Turning to the other end of the series we can fancy that there are organ-

[1] Read before the Chicago chapter of the Sigma Xi, March 11, 1920.

izations of galaxies, say super-galaxies, and still higher organizations of super-galaxies, and so on without limit. To be sure this is mere speculation and rests upon no direct physical evidence. But let us not forget that even in the days when the atom was our smallest physical unit there were many men who refused to regard it as such upon grounds which were purely metaphysical. The mere fact that the physicists have been able to take one more step down the series by conquering the extraordinary experimental difficulties, and that the astronomers in their turn are beginning to perceive in the spiral nebulæ other galaxies than our own is quite encouraging to the purely metaphysical notion that the series of physical units is an unending one, without bottom and without top.

Thus we have a conception of an infinite, three-dimensional continuum of space about which we can move at will, at least within certain limits; a conception of an infinite one-dimensional continuum of time through which we move always in one direction, without choice on our part; and finally, a conception of an infinite one-dimensional series of physical units in which our position is fixed—it is only in thought that we can move along this series. If to these we add energy and consciousness, neither of which admit the notion of dimensions, we have perhaps exhausted the catagory of fundamental conceptions.

The physicists and astronomers have nothing to do with consciousness objectly. They are interested only in the conceptions of space, time, the series of physical units, and energy. In particular, they are interested in the properties of the physical units, the nature of their wonderful organizations and the flow of energy which is associated with them. The astronomers, fortunately, are able to furnish us with photographs of the objects with which they deal, so that we are able to study them more or less thoroughly one at a time. No two of the galaxies are alike in detail although in their broad outlines there are striking similarities. The globular cluster is one type of organization of which we have some eighty specimens, and the spiral cluster is another, and of these we have some hundreds of thousands.

Descending from the galaxies to the stars we are unable to make out the structural details notwithstanding their vast size, owing to their still more vast remoteness. Only one specimen, our own sun, is sufficiently friendly to submit to anything like a close inspection. Nevertheless a classification of the stars according to their colors and their types of spectra is entirely possible. Thus the inherently brilliant white Orion-type stars have continuous spectra, save for a few broad lines of absorption due to helium and hydrogen, with a complete absence of the metallic lines. The brightest part of the spectrum is in the violet. Then come the stars of the solar type with the yellow as the brightest part of the spectrum, with many lines of hydrogen and the metals. Then the orange stars with metallic lines and absorption bands due to chemical compounds. Finally, the deep red stars with heavy absorption bands due to carbon compounds. The individualities of the stars, however, are preserved for no two of the spectra are exactly alike.

Nothing need be said with respect to ordinary masses, for they are matters of our everyday experience. No two leaves even from the same tree are exactly alike. But when we descend to the stage of the molecules the situation is very different. The physicists have not yet given us any photographs of them to study, and no one can say that he has ever seen a molecule. Their numbers are so amazingly great that an individual study of them is quite out of the question. Nevertheless, as the chemists assure us, classification is quite possible, and their variety is astonishingly great. But when we study the properties of even a single variety and attempt to work out their structural organizations we must not forget that it is only the properties common to large numbers which stand out and characterize the variety. If the human race could be studied only through the statistics of population, we might arrive at the conclusion that the Chinese are a

variety of the human race, but that one Chinaman was just like another. Analogy would lead us to doubt whether all the molecules even of water are alike. Could they be examined individually and in detail, marked differences would probably be found.

The case is similar with respect to the atoms, although the number of varieties of atoms seems to be limited while the number of varieties of molecules does not. Our information with respect to atoms is largely statistical. But even so, the chemists are recognizing the isotopes of the various elements, and certainly two varieties of lead are now known where previously we had but one; illustrating beautifully the principle that differences and individuality tend to grow with increasing acquaintance.

When we descend one more step in the scale of the physical units and reach the electrons, we are so remote from our own position in the scale and our acquaintance with these units is so far from being intimate that it is not surprising that we regard all positive electrons as being alike, and all negative electrons as being alike. We seem to have reached that ultimate simplicity for which the mind is always seeking. Nor is our information with respect to the electron entirely statistical, for Millikan has performed the amazing feat of measuring their electrical charges one at a time, and finds that in this respect they actually are measurably alike. So far then as we think of the electron as possessing the single property of the electrical charge we are justified in assuming that they are all alike. The human mind, however, is incurably speculative, and few of us, I fancy, would be willing to admit that this is their only property, or that the electrons really are all identical, or that the electron is not still further resolvable into smaller units.

Since the beginning of the present century the physicists have been very busy with the atom. The phenomena of radioactivity and of the X-rays have led them along a brilliantly lighted path in their exploration of its interior, and they have supplied us with verbal pictures of considerable clearness. The electrical charge of a positive electron is numerically equal to the electrical charge of a negative electron, but its mass is nearly two thousand times greater while its diameter is only one two-thousandths as great. If we could apply the ordinary notions of density to these statements we should have to say that the density of a positive electron is ten million million times the density of a negative electron, although its electrical charge is equal. But the ordinary notions of density perhaps do not apply.

If we accept the picture that a hydrogen atom consists of a negative electron moving in a circular orbit about a positive electron, we have so far as relative sizes and distances are concerned a veritable planetary system, except that the diameter of the satellite is two thousand times the diameter of the primary, for their distances apart are relatively as great as between the sun and Neptune. The nucleus of a helium atom has two free positive electrical charges and two negative satellites; lithium has three, and so on; there is a chemical element for each integral multiple up to 92 which belongs to the element uranium, with perhaps a half dozen gaps in the entire series; and furthermore, there is no chemical element which does not fit into the series. We have therefore a complete ordering of the chemical elements upon a purely numerical basis, which makes intelligible the periodic law of these elements which has been long known by the chemists on the basis of their chemical properties.

Notwithstanding the brilliant achievements of the physicists in their work with the atom their analysis is by no means completed. Many fascinating questions remain to be answered. For example, are all of the elements merely hydrogen atoms locked together in a very tight embrace, and if so will a sufficiently violent bombardment separate them? Rutherford's success in obtaining hydrogen from nitrogen by a bombardment with α-particles is certainly suggestive. If the answer is to be in the affirmative, what is the nature of this embrace? How do the electrons, positive and negative, arrange themselves?

How are the lines in the spectrum to be accounted for? And how does an atom radiate energy, anyway? It is a delightful situation for the mathematical physicist to face, for he has already achieved a very solid foothold, and we may be sure he will not be slow to push his advantage.

If the private affairs of the atom belong to the domain of the physicist, their social affairs belong to the chemist. And what tremendously social creatures they are! Few of them are content to live by themselves. The vast majority of them cling more or less tenaciously to other atoms or groups of atoms, and these groups are the chemists' molecules, the smallest particles of what we call ordinary matter. This grouping is not a mere random affair. The atoms exhibit a distinct choice not only as to their associates but as to the manner in which they will associate together.

Just as the physicist has his problems as to the structure of the atoms so the analytical chemist is busy breaking up the almost infinite variety of molecules he finds about him to learn what atoms enter into their structure and what are the relations which exist between those atoms. In this endeavor he has been highly successful and the great majority of molecules he can read as an open book, but the subtile strain of carbon molecules will doubtless tax his ingenuity for a long time to come. On the other hand, the synthetic chemist is slowly learning how to coax the atoms into those particular groups which either his theory tells him are possible or for which nature herself has already furnished an example. In the domain of ordinary masses the architect and engineer, the painter and sculptor and the skilled artisans of a thousand varieties have learned how to build up their structures to suit their various purposes. But the physicists have not yet dreamed of building up an electron nor an atom. The biologists have little hope of ever constructing a living organism. The geologists are content to examine their rocks and to make the past live again in their vision; while the astronomers in the very nature of things must maintain a respectful distance from the objects which engage their interest. Outside the domain of ordinary masses it is the synthetic chemist alone who can engage in the process of physical construction, the building up of those units which are the object of their study. The world is very greatly their debtor to-day, and this debt will increase enormously as the chemists rise higher and higher in their ability to control the groupings of the atoms in the molecules.

Our greatest familiarity and closest intimacy with nature naturally lies in that portion of the scale of physical units to which we ourselves belong, viz: ordinary masses. It is here that the geologists and biologists are at home. But so infinitely varied is the aspect here presented to us that these sciences divide and subdivide in their study of particular phases of things that we seem to have a whole host of sciences. To geology belong such sciences as meteorology, geography, paleontology, and mineralogy. Biology divides into the two great branches, zoology and botany, and these two branches subdivide and split up very much like the cells, about which they are so fond of talking, until one is actually lost in their numbers. Resting securely above these, at least so far as complexity of their phenomena is concerned, are the psychologists and sociologists.

Would an inhabitant of an atom, supposing him to be as small relatively as we are to the earth, find the world about him as complicated and varied as we find ours to be? Would he require a thousand and one different sciences, of which we do not even dream, in order to interpret what was going on about him and adapt things to his use as we are doing? Fortunately science does not have to answer, for there is no evidence. Science always turns away disdainfully when there is no evidence, and rightly so. It is none of her affair. But the same human being, if he is a scientist, is also a philosopher and a speculator. Perhaps he is a scientist because he is a philosopher and a speculator. At any rate, we can not but be impressed with the richness and luxuriance of our own field of units when we compare it with the poverty with which our mental pictures

endow the other fields; and so far as I am concerned, at least, I am willing to admit that this striking contrast is a fair measure of our ignorance with respect to what is going on in these other fields.

Turning our eyes upward towards the sky we see the friendly stars, for they seem friendly to one who cultivates their acquaintance. Symbols, they are, of permanence and stability for they maintain their light and their positions unchanged century after century. In order to gauge their distances we have only to imagine our sun moved far enough away that its light is reduced to that of ordinary starlight. Our imaginations are utterly impotent to grasp the ninety-three millions of miles which separate us from the sun, but this distance, great as it is, must be taken three hundred thousand times to bring us even to the nearest star; and even this prodigious distance is less than the average distance between the stars. It is hard to appreciate the vastness of astronomical space. If two unlike things can be compared, we might say that the vastness of astronomical space is comparable with the vastness of the number of atoms. Imagine, if you please, fifty millions of atoms placed side by side. Their total span would be one centimeter. Imagine then the number of atoms in a cubic centimeter of water. It is something like 3×10^{22}. Think then of the number of atoms in the ocean, or in the entire earth; or worse still, in the entire solar system. It turns out that there are something like 6×10^{55} atoms in the entire solar system. But if we give to the sun its fair share of the empty space about it, about twenty cubic parsecs, we can say that the sun's share of space is 6×10^{56} cubic centimeters; so that if all the atoms in the solar system were uniformly distributed throughout the sun's share of space there would be ten cubic centimeters of space for each atom, and relative to their respective sizes the distances between the atoms would be just about the same as the distance between the stars. Under these conditions the inhabitants of an electron would have much the same problem in determining the ordinary properties of matter that we have in determining the collective properties of the stars.

In the process of extending our conceptions of space the astronomers have been magnificently in the lead. In the extension of our conceptions of time, however, they have allowed the geologists to take the lead, although, even without any specific evidence, one would be willing to admit that astronomic time must exceed geologic time as greatly as astronomic space exceeds geologic space. As would be expected direct evidence is very hard to get, as the three hundred years since the invention of the telescope, and the two hundred years since exact observations in the modern sense of the word began, is far too short an interval for much change to have occurred. The proper motion of the great majority of the stars is less than one second of arc in a century. In a million years these motions will be less than three degrees; and motions of this magnitude occur in the field of ordinary masses in about one second. On this basis one second would correspond with a million years, and the three score years and ten of human existence would correspond to over two million billion years. In our conceptions of ordinary time we have risen to a point where a human lifetime seems short. Shall we ever attain a viewpoint where the corresponding astronomical period seems short?

Just as in the kinetic theory of gases the collisions of the molecules are the important events from a dynamical point of view, so in our galaxy of stars the close approach of two stars is dynamically an event of fundamental importance. An approach as close as the earth is to the sun would be a close approach, and for any one star such a close approach may be expected once in four million billion years, or a little more than the corresponding lifetime. The importance of these close approaches will be appreciated if it is borne in mind that it is the only method which we know by which a star could be destroyed so that its identity would be lost; for, notwithstanding the temporary stars, internal explosions scattering the remains beyond the possibility of a gravitational reassembling is unbelievable, and

a slow evaporation would eventually reduce a star to an ordinary mass. The geologists give the earth five hundred million years or more in substantially its present condition so that if it is slowly evaporating the time required for it to completely disappear would be at least of the order of magnitude which we have just been discussing. Such evidence as we have, however, indicates that the earth is growing rather than diminishing. From the viewpoint of our galaxy, a million billion (10^{15}) years would seem to be a reasonable unit of time.

Once in a very long time a star through a series of unfortunate encounters with other stars will acquire so high a velocity that it will escape from our galaxy altogether, and like the lost Pleiad, wander hopelessly through the ages in search of its sister stars; but very many of our astronomical time units will have elapsed before this process could sensibly diminish the number of stars in the galaxy. Whether or not the galaxy is already very old as some of us think, or whether it is relatively young as is thought by others, it seems to be fairly clear that in the course of time, at least, it will be very old even as measured in our very lengthy time units. As we muse upon this certainty we wonder whether the light of the stars will go out; or will they continue to shine in the remote ages to come.

In the past a very great restraint has been placed upon our vision by the gravitational hypothesis as to the source of a star's energy. According to this hypothesis the gravitational potential energy of the star is converted into the energy of heat and light and radiated away. The entire life of our sun, at its present rate of living, could not possibly exceed fifty millions of years, and there is a similar restriction upon all of the other stars. Under no reasonable assumptions as to the rate of expenditure could the period be extended to more than a few hundred millions of years. At the expiration of this period the star becomes a cold and solid body and remains such until its very existence is snuffed out in some great catastrophe. It is much the same as though a child were intellectually bright for one, or two, or perhaps five minutes near the beginning of its life, and then all the rest of its existence was spent in mental darkness; and this was true, not as an accident, but as a regular thing.

The discovery of the subatomic energies, as manifested in the radioactive processes, some twenty years ago has helped the situation somewhat, lengthening the period of a star's brilliancy two, three, five, perhaps ten times, but that is all. The dismal picture remains, notwithstanding the protests of the geologists and the biologists, and the absolute failure of the astronomers to find any evidences of these cold and solid bodies and dead galaxies, which should be vastly more numerous than the live ones. But if the results are still unsatisfactory the discovery and exploration of the subatomic world has at least relieved us of a dogmatism which could say, and once did say, "You have so much time for your evolution. and no more." It has opened our eyes to the perception of new things, and awakened our minds to new possibilities for which direct physical evidence is still wanting.

The doctrine of the conservation of energy has been a well established doctrine among all classes of scientists for seventy-five or eighty years. Notwithstanding this, we have allowed the greatest flow of energy with which we are acquainted, the prodigious energy of the stars, to escape into the blackness of space unnoticed and forgotten, quite contrary to that somewhat more hazy doctrine which we call the economy of nature. We simply did not know what to do with it. Suddenly we discover that the atoms are wonderful organizations of energy. The vastness of their numbers, comparable only with the vastness of astronomical space, suggests that their organization is an astronomical matter, for the astronomers alone can furnish energy in sufficient amount and equip a laboratory of sufficient size. That the details of this equipment are unknown need occasion no surprise, but the products of this mighty laboratory are visible upon the sky. Irregular nebulæ of gaseous materials occupying enormous volumes of space are found in abundance there, and much evidence of dark nebulosity against

luminous backgrounds. Is it too much to suppose that these nebulæ consist of atoms recently formed in the laboratory of space and beginning to assemble for their careers in the world of matter? This would seem to be the simplest guess, and it is worth considering.

The physicists are inclined to believe that the property of mass is due to the electric charges of the electrons. If now a negative electron should collide and unite with a positive electron the electric charges would disappear, and so also would the property of mass. If the speed of this collision were equal to the velocity of light, which seems probable enough from the known speeds of the electrons then the energy set free is calculable. It is found that one gram of matter passing through such an experience would liberate five billion calories of heat. The unit resulting from this collision would not possess the property of mass, but it would be an organization of some kind. If we suppose that the radiant energy of the stars as it flows through space should succeed in splitting this unit again into two electrons the property of mass would be restored, but a corresponding amount of radiant energy would have disappeared.

So far as I know the physicists have not announced a law that for every positive electron there exists a corresponding negative electron, but the electrical neutrality of matter seems to imply that it is true. If the two kinds of electrons exist as the result of the splitting of a single unit it is easy to see why it should be true, but quite a considerable puzzle otherwise.

It seems almost axiomatic that no organized physical system can endure a condition of unlimited violence without breaking down; and since the atom is such a system it seems inevitable that under suitable conditions it will collapse, and its energy of organization will be set free. The extreme conditions as to temperature and pressure which exist in the interior of a star seem to make this an ideal place for an atom to break down and give up its energy and its property of mass, if such an event is to occur anywhere. Such a process seems almost necessary if we are to account for the energies of the stars over the extended periods of time which the dimensions and forms of the galaxies seem to imply. On such a basis the sun possesses in its present mass a sufficient store of energy to last, at its present rate of radiation, five thousand millions of years. Such a period of time is short from an astronomical point of view, but as the sun travels through space at a speed of about twelve miles per second it must pick up atoms, and molecules, and an occasional solid fragment, and in this way add to its mass. Occasionally it will pass through nebulous regions and add to its mass with relative rapidity. We can suppose that on the whole the sun, and the other stars also, gather in as much energy as they radiate, and the embarrassment arising from their relatively short periods of luminosity and their reckless expenditure of energy disappears.

To an audience of astronomers much could be said in favor of accounting for the sun's heat in this manner, but such evidence would be of but little interest to those who are not astronomers. The main point of interest to them would be that under this hypothesis the geologists and biologists are freed from the restraints as to time, for the astronomers could furnish them with all of the time which they wished. There would be no fixed upper limit to the life of the sun, and the stars in general could continue to illuminate their paths through space for indefinite ages still to come. The haunting fear of a general stellar death is gone and the forbidding picture of the galaxy as a dismal, dreary graveyard of dead stars fades away from our sight; and in its stead we see an indefinite continuation of our present active, living universe with its never-ceasing ebb and flow of energy. Those wonderful organizations which we call the physical units will continue to be built up when the conditions are favorable, pass their allotted time in such activities as are suitable to their nature, and finally yielding up the energy by which they were organized, be resolved again into the elements from which they came. The individual perishes, but the race lives on.

The astronomer with his telescope, the biol-

ogist with his microscope, the physicist with his spectroscope, and the mathematician with his logic are all busily engaged in unravelling the mysteries of the structure of the universe. They do not always think of their work in this relation. Ordinarily they will tell you that their work is directed towards the answer to some specific question in a relatively circumscribed field. But eventually the mental pictures which result from this detailed work are integrated into one grand picture of the structure of the universe itself, and all that is trustworthy in this grand picture rests upon the labors of the individual workers in their various fields.

There are certain questions, however, of a very fundamental character which no amount of labor will ever answer, and to these questions we are at liberty to return such answers as happen to please us. In other words, they belong to the domain of esthetics and not to the domain of science; and yet they are so deep and fundamental that all of our scientific pictures rest upon them. For example: Is the physical universe limited in space, or is it not limited? If it is not limited, or infinite as we say, is the portion of it which we see peculiar, or is it fairly representative? Is the epoch of time in which we live a peculiar epoch, or is it a fairly representative one? Is the universe as a whole definitely changing from its present state, or is it a permanent thing, the same yesterday, to-day and forever? I might continue with other and similar questions but there is not time now. You are at liberty to choose your own answers and upon them to rest your interpretation of the universe, or your philosophy.

For myself, I wish to think of the physical universe as infinite—it jars upon my sensibilities to think of it otherwise. I am unwilling to admit that we occupy an essentially peculiar position in either space or time. As for the universe as a whole, it has always been and always will be essentially as it is to-day. It is infinite, eternal and unchangeable.

William Duncan MacMillan
The University of Chicago

THE PAN-PACIFIC SCIENTIFIC CONGRESS AND THE BISHOP MUSEUM OF HAWAII

During the month of August, 1920, a congress will be held at Honolulu to outline the scientific problems of the central and southern Pacific Ocean, and to suggest methods for their solution. Delegates from Australia, New Zealand, the United States, and possibly Japan will take part in the discussions, and will formulate a program of research for future guidance in anthropology, geography, geology, and biology. Also it is hoped to lay a foundation for a greater utilization of the economic resources of the Pacific. The delegates are to be the guests of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History, situated in the city of Honolulu. It should be noted here that the idea of a wider Pacific exploration was first put forth by this museum in 1906, and that during the past thirty years the museum has been at work on the ethnology and biology of the central Pacific. Its trustees now desire to take up the wider problems of the Pacific—and they are of fundamental importance—in cooperation with other institutions of research. Yale University, as a result of a gift from Mr. Bayard Dominick of $40,000 for scientific exploration in the southern Pacific, is enabled to enter upon thorough cooperation in the plan, and Professor Herbert E. Gregory, of the Yale faculty, is now the director of the Bishop Museum and the leader of the congress. Other institutions which have expressed a desire to cooperate are the National Academy of Sciences, the National Research Council, the U. S. National Museum, the U. S. Coast and Geodetic Survey, the Carnegie Institution of Washington, Harvard University, the American Museum of Natural History, the California Academy of Sciences, and the Scripps Institution for Biological Research.

That the results already accomplished by the Bishop Museum are extensive may be gathered from the following account. Fernão de Magalhães, making his way southwest across the rough Atlantic, was the first to

pass through the Straits of Magellan, and for nearly four months subsequent to November 28, 1520, sailed over what seemed to him the quiet waters of an unknown ocean, which he accordingly named the *Mer Pacifico*. The Hawaiian Islands were, however, not discovered until 1778, by the world navigator, Captain Cook, who landed on Kauai. In the spring of 1820 a small sailing ship landed a number of New England missionaries in Hawaii, and from that time began the modernization of human culture on the eight inhabited islands of the group. Thus arose the dominancy of the United States in these islands, which were formally annexed in 1898 and constituted the territory of Hawaii in 1900.

Mr. Charles Reed Bishop, of New York, married Princess Bernice Pauahi, the great grand-daughter of the Moi of Hawaii at the time of Cook's visit. She died in 1884, leaving her estate to establish "schools for the youth of her race"; she is often referred to as the "mother of Hawaiian industrial education." In 1889 Mr. Bishop founded in her memory the Bernice Pauahi Bishop Museum, and the following year Dr. William T. Brigham was chosen as its curator, becoming director six years later. The government of the museum is in the hands of a board of seven trustees. The original museum was a small stone building, but two large additions have been made and now it is the leading storehouse of information relating to things Pacific, and more especially to the ethnology of the Polynesian people. The Hawaiian Hall opened in 1903 is unique among museums. This privately endowed institution has made good use of the capital left it, Director Brigham having twice visited the museums of the world in his endeavor to find the best methods of caring for the collections in his charge. Mr. Bishop died in 1915, in his ninetieth year, and Dr. Brigham became director emeritus in 1917. At this time the staff consisted of five curators and eight assistants.

In 1898, the Bishop Museum began the publication of two serials, the smaller Occasional Papers, of which there are now six volumes, and the quarto Memoirs, now in the seventh volume. In looking through these publications, one is impressed by the high scientific character of the studies and the splendid dress of the memoirs. The credit is all the greater, since the publications are not only written by the staff of the museum, but printed by its own presses. The results naturally bulk largest in ethnology, since this was the primary wish of Mr. Bishop. Moreover, the Hawaiian people are no longer living in their original culture, Christianity and the ways of the white man having completely changed their modes of life. The volumes by Dr. Brigham treating of the wonderful feather work done by the Hawaiians, the making of bark cloth, mat and basket weaving, the houses of the natives, their wood carvings and stone implements, are a revelation of the skill of this primitive folk. The director has also interested himself in different lines of study, as is apparent from the titles of others of his works which are of great value: "Index to the Islands of the Pacific," "The Volcanoes of Kilauea and Mauna Loa"—and some of the volcanoes of Hawaii rise to nearly 14,000 feet above sea level—and "A Journey around the World to Study Matters relating to Museums." There is no more interesting account of the world's natural history museums than this one published by Dr. Brigham in 1913.

Most interesting are the three quarto volumes on Hawaiian antiquities and folklore, gathered and written in the native language by Abraham Fornander and translated into English by Thomas G. Thrum. Another native manuscript on Hawaiian antiquities by David Malo is translated by N. B. Emerson.

A large monograph of the flowering plants of the family Lobelioideæ by Joseph F. Rock is a thorough piece of work, while Charles N. Forbes describes in the Occasional Papers many new species of indigenous plants.

The volumes also include a "Key to the Birds of the Hawaiian Group," by W. A. Bryan, and many smaller papers on birds by the same

author and by Alvin Seale. More than 300 species of Pacific marine fishes have been cast and colored from life by J. W. Thompson and described by Bryan and Seale. Of land snails in the islands there appears to be an endless variety, certainly more than 400 forms, and the Museum has them by the hundred thousand. These have been arranged and many new forms described by C. M. Cooke. The collection of marine shells have all been determined by W. H. Dall.

Clearly this is a good beginning toward the gathering of data looking to the solution of the problems of the Pacific Ocean.

Charles Schuchert

SCIENTIFIC EVENTS

COTTON RESEARCH IN LANCASHIRE

The British Cotton-growing Research Association has issued a report covering the first nine months of its work. According to an abstract in the London *Times* actual research work has as yet scarcely begun. Dr. A. W. Crossley, the director of research, was not free to leave the University of London until Easter. The council and director agree that the association's researches will achieve success in proportion to the extent to which they are organized on a cooperative basis, the workers in the several sciences directing their efforts towards the solution of a common problem. In order that the various departments should all be working at one center, a property, known as The Towers, has been acquired at East Didsbury, a Manchester suburb, and the council is about to issue a special building fund appeal for £250,000. The next step anticipated by the council is the appointment of heads of departments on the subjects of chemistry, physics, colloids, botany and technology. Dr. A. E. Oxley, of Cambridge and Sheffield Universities, has been appointed head of the physics department, and Dr. J. C. Withers, of the chemical department, St. Thomas's, London, has been appointed to direct the abstracting and indexing of scientific and technical information in the records bureau. It is stated that information is so scattered that it will be some time before a comprehensive idea can be given of the work accomplished in the past. The report adds that the chief aim will be to arrive at the principles or theory underlying the practise of the industry, leaving the application of the theory to those actively engaged in the industry. Applied research can not, however, be entirely omitted, especially in respect of such matters as may be considered beyond the resources of individual firms.

In cooperation with the Empire Cotton-growing Committee a joint committee has been appointed, with the immediate object of granting scholarships to graduate students, so as to secure a supply of trained men for the future. Three botanical research studentships have already been established. The total number of individual members of the association is 1,408. The income for the year, including £6,750 government grant, amounts to £17,150.

THE BRITISH SCIENCE GUILD

Nature reports the annual meeting of the British Science Guild held in London on June 8. Lord Sydenham, the president, in his address on "Science and the nation," discussed industrial problems, due partly to an abnormal state of mind arising from the war, but originally fostered by the industrial changes of the last century, namely, the general use of machinery, rendering labor monotonous and leaving less room for the individual skill of the craftsman, and the formation of large companies, whereby the personal touch between master and man was lost. In the latter portion of his address Lord Sydenham emphasized the importance of a more general knowledge of science, especially amongst members of the government and the Civil Service, and alluded to the efforts made by the Guild in the dissemination of scientific knowledge and methods. He concluded by quoting Goethe's saying that "there is no more dreadful sight than ignorance in action."

The president-elect, Lord Montagu, of Beaulieu, then delivered an address on "Some national aspects of transport," and afterwards occupied the chair. Lord Montagu remarked upon the growing difficulties of railways, which, although subsidized by the state, were

working with a diminishing margin of profit owing to the vast increase in cost of materials and in wages. In view of the national importance of these problems, the creation of a chair of transport at one of the leading universities would be a deserving object for private beneficence. The two institutions of Civil Engineers and Mechanical Engineers should be more frequently consulted by the government in regard to road transport, and the National Physical Laboratory had done excellent work. The problem, however, was so vast as to demand continuous research at a special establishment.

The annual report of the executive committee, summarized by Lord Bledisloe, dealt with various aspects of the work of the Guild. The second British Scientific Products Exhibition, held in 1919, was honored by a visit from both King George and Queen Mary, accompanied by Prince Henry and Princess Mary, and demonstrated the growing appreciation by British manufacturers of the value of applied science. During the present year it is hoped to arrange a conference on science and labor in association with the Labor party. A representative committee is being set up to collect full data on the utilization of science, not only in the civil services, but also in all government departments, and the Parliamentary committee, which has already intervened with good effect in the Forestry Bill, will watch all prospective legislation involving scientific and technical issues. The education committee of the Guild is still pressing for a real survey of the existing provision of university and higher technical education in the country, considering that the new standing committee on university grants, acting under the Board of Education, is inadequate as regards composition and reference. The revised specifications of the technical optics committee in regard to microscopes have already been adopted by two British firms.

THE DIVISION OF CHEMISTRY AND CHEMICAL TECHNOLOGY OF THE NATIONAL RESEARCH COUNCIL

THE annual meeting of the Division of Chemistry and Chemical Technology, National Research Council, held in Washington, on May 7, is reported in the *Journal of Industrial and Engineering Chemistry*. There were present Messrs, Alsberg, Bancroft, Bleininger, Derick, Fink, Francis, Johnston, Lamb, Moore, Noyes, Stieglitz, Washburn; and by invitation Messrs. Angell, Christian, Cottrell, Kellogg, Mendenhall, Munroe, and Yerkes.

The following officers were elected for the ensuing year: Vice-Chairman, Julius Stieglitz; Members-at-Large, A. A. Noyes, E. W. Washburn. The members of the Executive Committee will be the chairman and vice-chairman, C. L. Alsberg, A. B. Lamb, John Johnston, and W. D. Bancroft, *ex-officio*, retiring chairman. The American Chemical Society nominated C. L. Alsberg, W. D. Bancroft, and C. G. Derick as members of the division, and the American Institute of Chemical Engineers nominated H. K. Moore.

In connection with the meeting of the International Chemical Union to be held in Rome, Dr. Charles L. Parsons was appointed delegate. The admission to the Union of Poland and Czecho-Slovakia was favored, the division expressing the unanimous opinion that any neutral nation, eligible from the point of view of its scientific activities, that might apply for admission should be admitted.

In presenting the report of the Committee on Synthetic Drugs, Julius Stieglitz, chairman, pointed out the valuable work done by this committee in furnishing information and advce to manufacturers. The report of the Committee on Explosives Investigations was presented by the chairman, Professor Charles E. Munroe. The Committee on the Thermal Properties of Explosive Materials was not continued, the work being transferred to the Committee on Explosives Investigations. This latter committee was requested to associate with itself W. P. White and others interested in the study of the thermal properties of explosives. In the absence of H. N. Holmes, chairman of the committee on colloids, the report of the committee was presented by W. D. Bancroft.

Upon the suggestion of C. G. Derick, a committee on methods of organic analysis was appointed. The need for cooperation between

the various laboratories and individuals working on contact catalysis was pointed out by Chairman Bancroft, and as a result a Committee on Contact Catalysis was appointed, with W. D. Bancroft as chairman.

A report on the publication of critical tables of physical and chemical constants was presented by H. K. Moore. The council approved the suggestion that a special agent be employed to devote his entire time to the solicitation of funds for this publication. Thereupon H. E. Howe was appointed a fourth member of the board of trustees; W. D. Bancroft and C. E. Mendenhall was authorized to pay for the drawing up of a preliminary plan for the scientific organization of the tables, as a concrete basis for obtaining subscriptions.

Dr. Cottrell was appointed to draw up a resolution in support of the Patent bill, with instructions to forward the resolution to the Patent Office committee of the National Research Council for such action as it saw fit to take.

THE PERMANENT FUNDS OF THE AMERICAN ORNITHOLOGISTS' UNION

The *Auk* states that from time to time the union has established several permanent funds for special purposes. In every case the principal with such contributions as may be received is invested so as to remain intact and the interest only is used for furthering the objects of the fund. The most important of these funds are: the Brewster Memorial Fund, the Research Fund, and the Publication Fund.

The Brewster Memorial Fund, the most recent, is the gift of the friends of William Brewster to perpetuate the memory of one of the founders and former presidents of the union by establishing a fund to encourage research in American ornithology. The sum of $5,200 received in 1919, has already increased to some extent and the proceeds will be awarded biennially in the form of a medal and an honorarium to the author of the most important contribution to the ornithology of the Western Hemisphere during the two years immediately preceding. This fund is administered by a special committee and the first award will be made in 1921.

The Research Fund was established some years ago by a gift from Miss Juliette A. Owen, of St. Joseph, Mo., one of the Life Associates of the Union, to encourage original research in ornithology. It now amounts to several hundred dollars but the interest will not be available until the total amount reaches $5,000. It is highly desirable that this fund should be increased at an early date so that the proceeds may become available for promoting ornithological work. Already applications have been received for assistance in special investigations which would be greatly stimulated if small grants could be made from this or some similar fund.

The publication fund comprises receipts from life memberships, bequests and special contributions. In *The Auk* for January, 1920, the editor has called attention to the immediate need of a fund of $25,000, and in response to this appeal subscriptions of several hundred dollars in sums of $100 or less have already been received. The editor of *The Auk* says that not only is an adequate fund necessary to place the publication of the journal on a permanent basis and to issue check-lists, indexes and special bibliographies, but means should be provided also for publishing occasional memoirs, monographs and more extensive papers than have hitherto been attempted. At this time when the usual channels of publication are becoming restricted on account of the high cost of printing it is especially desirable that the American Ornithologists' Union should be in a position to meet the demands which are made upon it. As its permanent funds increase the union will be able to broaden the scope of its work and to make more substantial contributions both to the development and diffusion of knowledge of ornithology.

SCIENTIFIC NOTES AND NEWS

Dr. W. W. Campbell, director of the Lick Observatory, has been elected a foreign honorary fellow of the Royal Society of Edinburgh.

Dr. L. Hektoen, director of the John McCormick Institute for Infectious Diseases,

Chicago, has been elected a member of the Swedish Medical Society in Stockholm.

A PORTRAIT of Dr. Thomas Huston Macbride, president emeritus of the University of Iowa, was presented by C. F. Kuehnle, on behalf of the alumni to the university at the June commencement. The portrait was painted by Professor C. A. Cumming, of the department of graphic and plastic art, and is life size.

DR. ELIAS POTTER LYON, dean of the University of Minnesota Medical School, was granted the degree of doctor of laws by the St. Louis University at its recent commencement.

MORRIS SCHERAGO, formerly head of the department of bacteriology of the University of Kentucky, has been appointed assistant bacteriologist in the New York State Laboratory.

PROFESSOR J. G. GALLAN, of the department of steam and gas engineering of the University of Wisconsin, who has been on leave of absence during the present academic year, has recently resigned to become professor of mechanical engineering in Harvard University. He will teach factory administration and will also act as consulting mechanical engineer for an eastern manufacturing company.

WILLIAM D. ENNIS announces his resignation as professor of marine and mechanical engineering in the post graduate department of the United States Naval Academy, to become vice-president of the Technical Advisory Corporation of New York. Mr. Ennis has been associated with the latter corporation since its organization and will be hereafter located at its general offices, 132 Nassau St., New York City.

MR. ROBERT V. TOWNEND, chemist in charge of the chlorinated toluene products with the Semet-Solvay Co., has accepted a position with the Victor Talking Machine Co., Camden, N. J., where he will organize and direct their department of chemical research.

DR. N. E. DORSEY, who recently resigned as chief of the radium and X-ray section of the Bureau of Standards in order to take up private consulting and testing work, has been retained by the bureau in the capacity of consulting physicist.

WE learn from *Nature* that on the occasion of the birthday of the King of England the following were knighted: Professor F. W. Andrews, St. Bartholomew's Hospital; Captain D. Wilson-Barker, captain-superintendent of the trainingship *Worcester,* and past-president of the Royal Meteorological Society; Dr. J. C. Beattie, principal of the University of the Cape of Good Hope; Mr. W. B. M. Bird, founder of the Salters' Institute of Industrial Chemistry; Dr. H. H. Hayden, director of the Geological Survey of India, and Professor J. B. Henderson, professor of applied mechanics, Royal Naval College, Greenwich.

MR. O. F. BROWN, assistant inspector of wireless telegraphy in the Post Office, has been appointed technical officer to the Radio Research Board, which has been formed recently under the chairmanship of Admiral Sir Henry Jackson, in connection with the Department of Scientific and Industrial Research.

COLONEL H. G. LYONS has been appointed director and secretary to the Science Museum, South Kensington, in succession to Sir Francis Ogilvie, who has been transferred to the Department of Scientific and Industrial Research.

THE death is announced of Augusto Righi, the distinguished Italian physicist, professor in the University of Bologna.

PROFESSOR T. R. RYDBERG, of the University of Lund, elected a foreign member of the Royal Society for his researches in spectroscopy, has died at the age of sixty-five years.

A. A. INOSTRANSEFF, for many years professor of geology in the University of Petrograd, has died at the age of seventy-seven years.

DR. F. A. TARLETON, senior fellow of Trinity College, and formerly professor of natural philosophy in the University of Dublin, died on June 19.

A SURVEY of the steamer *Albatross* was made on May 25 and 26 by a board consisting of I. H. Dunlap, assistant in charge of office, Lighthouse Inspector J. T. Yates,

and Lieutenant Commander Henry B. Soule, United States Navy. A thorough examination was made and the vessel, while showing the effect of active service in which she has been engaged for the past six or eight months, was found to be in good condition and to require a relatively small amount of overhauling. Since the *Albatross* has been received back from the Navy she has been employed in investigations in the Gulf of Mexico and the Gulf of Maine.

The Civil Service announces an examination for research engineer. A vacancy at Watertown Arsenal, Watertown, Mass., at $3,000 to $3,600 a year, and vacancies in positions requiring similar qualifications may be filled from this examination. The duties of the appointee will consist of examination of research problems and the design of special apparatus in connection with experiments; submitting reports covering experiments; and, in some cases, putting the recommendations or findings into actual plant operation; also preparing reviews of scientific subjects, including translations from both French and German. The commission also announces an examination for scientific assistant, Bureau of Fisheries, to be held August 4, 1920. From this examination it is hoped to fill several vacancies in the Bureau of Fisheries at basic salaries of $1,200-$1,400 a year. Prospective candidates should apply to the commission for a copy of Form 1312.

A correspondent sends us the following letter from Professor P. Rona, of the University of Berlin.

> I have recently accepted the editorship of the *Zentralblatt f. Physiology*, published by Julius Springer. This journal has been organized along the lines of the *Chemische Zentralblatt* and will take in the entire field of biology. Foreign papers, that is non-German publications, will be given particular consideration.
>
> It would therefore be of extreme importance if I could receive, with your assistance, all the American publications, either in exchange or as reprints, and if necessary through subscription to such journals. The latter, however, would be out of the question for the present on account of the high rate of exchange. Of equal importance to us would be the reports of the various agricultural and biological stations, etc., which are not available at the ordinary publishers.

A letter has been received by the president of Columbia University, from Professor Albert Einstein, of Berlin University, thanking the trustees of the university for the Barnard Medal, conferred on him at this year's commencement on nomination of the National Academy of Sciences "in recognition of his highly original and fruitful development of the fundamental concepts of physics through application of mathematics." The letter says: "I beg to express to you my glad thanks for the great honor which you propose to do me. Quite apart from the personal satisfaction, I believe I may regard your decision as a harbinger of a better time in which a sense of international solidarity will once more unite scholars of the various countries."

Dr. Thomas P. Foley, chairman of the contract practise committee of the Chicago Medical Society, has started a movement among the members of the society to organize a union and has made the following statements:

> Why should a physician, who has studied for years to perfect himself for his work, be paid less than an unskilled laborer? Yet it is the rule rather than the exception.
>
> Recently a physician giving full time to industrial surgery in a large Chicago plant, rendered first aid to a man working as an unskilled laborer. The physician received $75 a month with room and board. The laborer's pay check for one week, which he showed the physician, was for $80.
>
> Take the state service for example. At the Dunning Hospital for the Insane the chief electrician stands next on the pay roll to the superintendent. His salary is $265 a month. That of the highest paid physician on the staff is only $245. The electrician is a union man. The physician has no organization back of him.
>
> We propose to form an organization along semi-union lines in Chicago like the lawyers' association and other such bodies of professional men. It is not aimed at the public, but rather at industrial and other corporation employers of physicians.

UNIVERSITY AND EDUCATIONAL NEWS

OHIO STATE UNIVERSITY has received a gift of $400,000 by Charles F. Kettering, a trustee of the university, for medical research in connection with the college of homeopathy.

W. A. CLARK, JR., of Butte, Montana, has presented a fund of $4,000 to the geological department of the University of Wisconsin for the purchase of equipment for experimental work in structural geology.

THE University of Wisconsin has obtained legal authority to offer a complete four year medical course.

DR. CHARLES B. FULTON, of Cleveland Ohio, has been appointed a director of the School of Mines and Metallurgy, Rolla, Mo.

DR. EMERY R. HAYHURST, professor of hygiene at Ohio State University, has been made head of the department of Public Health and Sanitation and Mrs. Norma Selbert, formerly of the University of Missouri, has been appointed assistant professor of public health nursing.

DR. W. THURBER FALES, of Malden, Mass., has been appointed instructor in biology and public health in the medical school of the Johns Hopkins University.

DR. V. J. HARDING, associate-professor of biological and physiological chemistry at McGill University, has been appointed professor of pathological chemistry in the University of Toronto.

DR. DOWELL YOUNG, of Cornell University, has been appointed professor of biology in Dalhousie University, Halifax, in place of Professor C. Moore, resigned.

AT the University of Leeds Dr. W. E. S. Turner has been appointed professor of glass technology, Mr. J. Husband professor of civil engineering and Dr. Mellanby professor of pharmacology.

DISCUSSION AND CORRESPONDENCE

THE RESCUED FUR SEAL INDUSTRY

AT the St. Louis fur auction held on February 2, 1920, there were sold for the United States government 9,100 skins of fur seals, the net proceeds of which were $1,182,905, an average of $140.98 per skin.

That sale marks an important period in the history of the most practical and financially responsive wild life conservation movement thus far consummated in the United States. In 1911 one of the stakes set by the advocates of the five-year close season was a return to a revenue of at least "$1,000,000 per year," and now it is no exaggeration to say that the results of the long close season that began in 1912 and ended in 1917 have been everything that the close-season advocates claimed that they would be.

The steady and very rapid increase in the fur seal population of the Pribilof Islands during their five years of immunity from commercial slaughter is revealed by the following official census figures as made by the United States Department of Commerce, and kindly furnished by Secretary Alexander.

In 1912 there were 215,738 seals of all ages.
In 1913 there were 268,305 seals of all ages.
In 1914 there were 294,687 seals of all ages.
In 1915 there were 363,872 seals of all ages.
In 1916 there were 417,281 seals of all ages.
In 1917 there were 468,692 seals of all ages.
In 1918 there were 496,432 seals of all ages.
In 1919 there were 530,237 seals of all ages.

The total number of fur seals killed for their skins since the open season began have been as follows:

In 1918 the number was 34,890.
In 1919 the number was 27,821.

The prices realized at the St. Louis fur auctions on the sale of fur seal skins are revealed by these figures:

In 1918 there were sold 8,100 skins for $375,385. Average, $46.34 per skin. In 1919 there were sold 19,157 skins for $1,501,603. Average, $78.38 per skin. In 1920 there were sold 9,100 skins for $1,282,905. Average, $140.98 per skin. If the average price of $140.98 at which the lot of 9,100 skins sold on February 2, 1920, should hold for the entire

catch of 27,821 skins taken in 1919, the total gross revenue for the lot would be $3,922,204.58.

In view of the feverishly advancing prices of all kinds of real fur, the growing scarcity of the supply, and the clamorously insistent demands, both of the rich and the poor, there are good grounds for the belief that very soon we will see good raw fur-seal skins selling at auction at an average price of $250 each. With 110,000,000 people in America demanding "fur," the future of the trade in real fur is remarkably bright—so long as the supply lasts—and Congress may regard the future of the nation's fur seal industry with entire complacency. The saving of the fur seal herds was a good investment.

In the future, when all other bearers of good fur have been utterly exterminated—*as they soon will be*—the protected fur seal herds will produce, by sure-and-certain arithmetical progression, a really vast quantity of the finest fur in the world. It needs no stretch of prophecy to foretell the annual increment to the three nations who now are so sensibly preserving the fur seals of Alaska from killing at sea. When we begin to take, as we formerly did in the days of the fur seal millions, an annual catch of 100,000 skins, the importance of the salvaged fur-seal herd will be realized. If we figure it out on a basis of the sale of February 2, 1920 at St. Louis, the answer is $14,098,000 *per year*, 75 per cent. of which will belong to the United States.

Under the terms of our treaty with England and Japan we are dividing net proceeds with those two partner nations, who now help us to preserve the fur seals when at sea, on the perfectly fair basis of 15 per cent. to Japan, and 10 per cent. to England. During the five-year closed season we annually paid to each of those two nations the sum of $10,000.

In its habits the fur seal—which in reality is not at all a true seal, but a fur-coated sea-lion—is one of the most remarkable of all sea-going mammals. There are writers who still insist that fur seals can be managed by man just as a farmer manages his herds of breeding cattle and horses. As a matter of fact, the fur seal is hopelessly wild and untamable, and the only "management" that man can bestow upon the free animal is in terms of slaughter. He can drive it and kill it by artificial or by natural selection, but that is absolutely all. The fur seal migrates, returns, breeds and feeds solely in accordance with its own erratic and persistent will, and man's so-called "management" lies solely in the use of the seal-killer's club and the skinning-knife.

William T. Hornaday

New York

SIDE-TO-SIDE VERSUS END-TO-END CONJUGATION OF CHROMOSOMES IN RELATION TO CROSSING OVER

The stonefly, *Perla immarginata* Say, is exceptionally fitted for chromosome studies as it has only five pairs (including the X-Y pair) of chromosomes, each pair of which is structurally differentiated from all others. My observation on this form made in 1917–18 forced me to the conclusion that in the prophase of the first spermatocytic division "homologous chromosomes are connected to each other telosynaptically in the spireme," and later "they bend toward each other at the synaptic point and become reunited parasynaptically before metaphase." These conclusions are in agreement with a limited number of workers but are so opposed to the general contention of the majority of cytologists to-day that it was considered then unprofitable to do anything more than describe the process as observed. This was done in my previous paper in the *Journal of Morphology*,[1] in which no attempt was made at theoretical discussion in relation to certain genetical evidences.

As so convincingly summarized in Morgan's recent book,[2] Mendel's original law—the segre-

[1] Nakahara, W., "A Study on the Chromosomes in the Spermatogenesis of the Stonefly, *Perla immarginata* Say, with Special Reference to the Question of Synapsis, *Jour. Morphol.*, Vol. 32, 1919.

[2] Morgan, T. H., "The Physical Basis of Heredity," 1920.

gation and independent assortment of factors —has been shown to have a close parallelism with the actual behavior of the chromosomes. The situation is quite otherwise, however, as to the mechanism of crossing over. Morgan is right when he states that "while the genetic evidence is favorable in all essentials to the theory of interchange between homologous chromosomes, it must be confessed that the cytological evidence is so far behind the genetic evidence that it is not yet possible to make a direct appeal to the specific mechanism of crossing over on the basis of our cytological knowledge of maturation stage." Morgan, however, assumes the side-to-side conjugation as a fact. His analysis of data on parasynapsis leads him to the conclusion that the early thin thread stage is most favorable for crossing over to take place. End-to-end conjugation, or telosynapsis, according to Morgan, "would have serious consequence for genetics . . . , for while side-to-side union offers an opportunity for interchange between the paternal and maternal members of a pair, no such interchange could be postulated if end-to-end conjugation took place."

It is the purpose of the present note to emphasize that the process of end-to-end conjugation, at least as described by Nothnagel[3] for a botanical object, and by myself[1] for a zoological one, does offer an opportunity for crossing over to take place, contrary to Morgan's statement. End-to-end conjugation simply restricts the stage in which such an opportunity is offered. This can be readily seen from the works of the above-mentioned authors, who describe essentially the following process:

A separate loop or segment of double spireme, whatever the nature of its duality may be, gradually bends and halves of the loop come to lie closely side by side. In the tetrad thus formed there are four longitudinal strands or threads.

It will be seen, then, by telosynapsis, an opportunity is offered for interchange between

[3] Nothnagel, M., "Reduction Division in the Pollen Mother Cells of *Allium tricoccum*," *Bot. Gaz.*, Vol. 61, 1916.

chromosomes at the thick thread stage, but at this stage only, in the manner originally suggested by Janssen[4] in his chiasma type

It must be remembered that the condition of the chromatin threads at the early stage when the double spireme develops is extremely difficult to study minutely and accurately with the method and apparatus at our command. Under such circumstances, any inclination on the part of the observer will have a considerable influence on the interpretation. If one is so disposed, he may consider the condition of the threads as representing the process of pairing up. Dual threads develop out of reticulum at this stage, and that was all I could be sure of. There was certainly no observable evidence of the process of pairing up of two simple threads at least in the stonefly I studied.

On the contrary, the formation of a tetrad or ring by the bending of a loop of double spireme, which appear in haploid number is a clearly demonstrable fact. It is from this ground that I interpret the haploid as being composed of two homologous chromosomes jointed up end-to-end, and its duality as indicating primary splitting. No one has ever seen two chromosomes actually coming into conjugation, but the subsequent bending, reconjugation in side-to-side position, and the ultimate segregation at metaphase, of the halves of the loop is explicable only under the assumption that two chromosomes were united end-to-end in the loop.

Whether I am right in this interpretation or not will be decided by future studies—perhaps in very near future. Detailed comparison of the premeiotic stage with the prophase of somatic mitosis would throw some light on the situation. Also, a careful re-examination of forms (Orthoptera, for instance), in which parasynapsis is customarily claimed to occur, with special reference to the haploid loops in the thick thread stage would help settle the question. Possibility no doubt exists that the

[4] Janssen, F. A., "La théorie de la chiasmatypie. Nouvelle interprétation des cinèses de maturation," *La Cellule*, T. 25, 1909.

theory.

process may be different in different organisms, but I consider it rather improbable in view of the fact that both para- and telosynapes have been described for different groups of plants and animals, and especially since certain "evidences" involved in the argument are not easily observable.

Summing up: contrary to the general belief, so-called end-to-end conjugation does offer an opportunity for interchange between chromosomes at the late thick thread stage in the prophase of maturation division, but at this stage only. If telosynapsis is a universal phenomenon, it would seem that crossing over must take place at the stage here specified. Of course, no morphological evidence has yet been produced for crossing over, and the most that can be said from the present cytological data is that such an interchange is not impossible at a certain stage in the muturation division.

WARO NAKAHARA

DESTRUCTION OF ZOOSPORES OF PLANT DISEASE ORGANISMS BY NATURAL ENEMIES

IN making some motion-picture photomicrographs of the liberation of zoospores from the sporangia of *Physoderma zeæ maydis* (see Tisdale, *Jr. Agr. Res.*, Vol. 16, p. 137, 1919) the author observed destruction of the zoospores by certain animalcules which are commonly found in decaying vegetable material. No reference has been found regarding the importance of these natural enemies of the plant diseases which are disseminated by zoospores.

The number of zoospores swallowed by one rotifer (*Proales* sp.) is remarkable. When the animalcules are abundant there is a speedy disappearance of the zoospores. One infusorian (*Keronia* sp.) was observed to devour a perfect stream of the zoospores of *Physoderma*, at the same time increasing in size until it became gorged almost beyond recognition.

In active cultures one may see a field in the microscope filled with millions of zoospores swimming about. In a few hours large numbers of these have been devoured by the animalcules, which rapidly increase in numbers. A few hours after this one then sees these same protoplasm constituents swimming about not as zoospores but as animalcules. The process of change is so rapid it makes one wonder if there is always cleavage of the proteins and resynthesis or whether there may not be some shorter method of assimilation especially in the unicellar organisms in which the cytoplasms of the infusorian and the zoospore ingested are in such intimate contact.

In starting from dry material collected from cornstalks infested with *Physoderma*, the animalcules appear first and are on hand for each crop of zoospores.

It would be desirable to determine just how important such animalcules are as natural enemies of those plant diseases which are disseminated by zoospores. Also we should collect data to determine if the destruction of the soil animalcules by excessive liming may not be correlated with epidemics of these diseases.

R. B. HARVEY

U. S. DEPARTMENT OF AGRICULTURE

THE JOURNAL OF MORPHOLOGY

AT its annual meeting in St. Louis, the American Society of Zoologists voted to accept the proposition made by Dr. M. J. Greenman, of the Wistar Institute, that in the future the society should assume control of the scientific policy of the *Journal of Morphology* and elect the editorial board, while the Wistar Institute retained control of the financial management of the journal.

A committee composed of M. M. Metcalf, Caswell Grave and W. E. Castle was appointed to initiate a scientific policy; to nominate an editorial board; to consult with the advisory board of the Wistar Institute and to refer its recommendations for final decision to the executive committee of the society.

This committee on publication and the executive committee and the Wistar Institute have agreed to the following action which accord-

ingly forms the basis for the cooperation between the American Society of Zoologists and the Wistar Institute regarding the *Journal of Morphology*. The full report of the committee will be published in the proceedings of the 1920 meeting of the society, but on account of the general interest the following summary is presented at this time:

I. That there be elected a managing editor of *The Journal of Morphology* to serve for a period of five years and that he be eligible for reelection at the expiration of his period of service.

II. That there be elected nine associate editors of *The Journal of Morphology;* three to serve until January 1, 1922; three to serve until January 1, 1923; and three to serve until January 1, 1924.

That beginning with the annual meeting of the society at the end of the year 1921, and annually thereafter, there be elected by the society upon nomination, by the same method as is provided for the nomination of other officers, three associate editors to serve for three years to take the places of the three retiring associate editors. That before making nomination of such associate editors, the nominating committee shall consult the board of editors of *The Journal of Morphology* and also the director of the Wistar Institute and through him the Board of Advisers of this institute.

This is suggested as a matter of courtesy to the institute, not as a matter of necessity, for the election of the editors of this journal shall lie with the society.

That a retiring associate editor shall not be eligible for reelection until after the expiration of one year subsequent to his retirement.

III. That the three incoming associate editors be constituted a consulting committee to visit the Wistar Institute at its invitation and expense, to serve as a means of cooperation between the two organizations.

IV. That the board of editors make annual report to the society upon *The Journal of Morphology* and any matters of publication that they may wish to include.

V. That the consulting committee, or any of its members, if they desire to do so, may report any year to the society any suggestions or recommendations growing out of their visit to and consultations with the Wistar Institute.

VI. That Professor C. E. McClung be elected managing editor of *The Journal of Morphology.*

VII. That associate editors be elected as follows:

1. To serve until January 1, 1922:
   Professor Gary N. Calkins.
   Professor J. S. Kingsley.
   Professor William Patton.
2. To serve until January 1, 1923:
   Professor E. G. Conklin.
   Professor M. F. Guyer.
   Professor W. M. Wheeler.
3. To serve until January 1, 1924:
   Professor C. A. Kofoid.
   Professor F. R. Lillie.
   Professor J. T. Patterson.

VIII. That matters of editorial policy and method, not covered by the present report, be left to the board of editors, subject of course to any action of the society.

It may be well to state that no fundamental changes in the character or conduct of *The Journal of Morphology* are contemplated.

W. C. ALLEE,
Secretary-Treasurer

SPECIAL ARTICLES

A SIMPLIFIED NON-ABSORBING MOUNTING FOR POROUS PORCELAIN ATMOMETERS

SINCE the introduction of porous-porcelain atmometers[1] into general use among physiologists, ecologists and agricultural experimenters, it has been realized that one of the most important details of the operation of these instruments in the open depends upon the fact that the porous, water-imbibed surface absorbs water during rains unless special precautions are adopted to prevent this. Mounted on a simple tube, as for laboratory use, these instruments always give negative readings for periods of rapid precipitation. At the end of a rainy day the reading may be considerably smaller than it should be to represent merely the summation of all incre-

[1] Livingston, B. E., "The Relation of Desert Plants to Soil Moisture and to Evaporation," Carnegie Inst. Washington Publ. 50, 1906. *Idem,* "A Simple Atmometer," SCIENCE, 28: 319–320, 1908. *Idem,* "Atmometry and the Porous-cup Atmometer," *Plant World,* 18: 21–30, 51–74, 95–111, 143–149, 1915. Other references are given in these papers.

ments of water-loss by evaporation. The reading may be nil or even negative (entrance of water into the reservoir), in spite of the actual evaporation of significant amounts of water from the instrument during the periods between showers.

It is not feasible to correct for these errors of water absorption, but the difficulty has long been practically overcome by the employment of a rain-correcting, or non-absorbing, mounting for this kind of atmometer when operated in the open during rainy weather.[2] All the non-absorbing mountings thus far suggested depend upon a mercury valve that allows water to pass through the tube freely in the upward direction, but practically prevents movement downward. As soon as liquid water is deposited on the exposed porous surface the surface automatically becomes virtually impervious to water from without, and the precipitation water runs off from the instrument as though it were glazed. When the rain ceases the valve reverses and evaporation soon begins to be registered as water-loss from the reservoir. Various types of mercury-valve mounting have been described, but the Shive form has been most generally used. All these non-absorbing mountings are relatively expensive, and the least expensive one (Johnston's) involves the use of rubber and requires special care in the installing of the instrument.

A much simpler form of mounting than any hitherto sugested has recently been tested in the Laboratory of Plant Physiology of the Johns Hopkins University. The purpose of this paper is to place the new modification in the hands of those who are interested in atmometry, so as to save them the expense and troubles of the more complicated mountings.

2 Livingston, B. E., "A Rain-correcting Atmometer for Ecological Instrumentation," *Plant World*, 13: 79–82, 1910. Harvey, E. M., "The Action of the Rain-correcting Atmometer," *Plant World*, 16: 89–93, 1913. Shive, J. W., "An Improved Non-absorbing Porous-cup Atmometer," *Plant World*, 18: 7–10, 1915. Johnston, E. S., "A Simple Non-absorbing Atmometer Mounting," *Plant World*, 21: 257–260, 1918.

The new mounting is very simple. The porous-porcelain piece is mounted in the usual way, by means of a rubber stopper, on the upper end of a glass tube of suitable length and having a bore of about 6 or 7 mm. This tube bears a second rubber (or cork) stopper somewhat below the first, which fits the mouth of the reservoir bottle and closes it completely as far as entrance of rain-water is concerned. The reservoir stopper is not slotted to allow air entrance to the reservoir, but access of air to the interior is allowed through a short, inverted-U-shaped glass tube, one arm of which is longer and penetrates just through the reservoir stopper from without, while the other arm is shorter, is directed downward and terminates a few millimeters above the upper surface of the stopper. This U-tube may be very small and its end may be loosely plugged with glass wool to exclude insects, etc. A water-proof apron over the top of the reservoir may be employed (Livingston, 1908), or other devices to allow air entrance and to exclude rain water may be used.

Thus far we have an *absorbing* mounting, suitable only for indoor operation or for periods without precipitation. But a very simple and efficient mercury valve is inserted in the upper end of the straight tube, as follows. A tightly rolled plug of glass wool (about 1 cm. long) is inserted in the upper end of the tube, the outer end of the plug is cut off so as to have a flat surface, and it is pushed into the tube until its upper end is about 2 cm. from the top of the tube. Next, a small amount of mercury is placed in the tube above the plug (the mercury column being 5–8 mm. high) and another plug of like nature is inserted above the mercury. The mercury is imprisoned between the two plugs and can not escape, in whatever position the tube is placed.

To install the instrument, the tube is inverted and the end bearing the valve is inserted in distilled water while suction is applied at the other end. Water enters freely through the valve and the tube is nearly filled in this way. Then the porous-porcelain

piece (cylinder, sphere or Bellani plate) is filled with distilled water and the tube is set into the porcelain piece, with the rubber stopper pressed firmly into the neck. The tube is next completely filled with distilled water, by pouring from the reservoir bottle (previously filled), and then it and the porcelain piece together are quickly inverted and the free end of the tube is inserted into the reservoir in the usual manner, the second stopper closing the reservoir.

With the arrangement here described water does not pass downward through the valve, but it readily passes upward, keeping the evaporating surface supplied. This mounting appears to operate perfectly, just as well as do the more complicated forms, it is more easily installed than they, it is easily constructed and the materials are inexpensive and readily obtainable.

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THE IOWA ACADEMY OF SCIENCE

THE thirty-fourth annual session of the Iowa Academy of Science was held in Physics Hall of the State University at Iowa City on April 23 and 24. At the opening session on Friday afternoon, the twenty-third, the memorial portrait of the late Dr. Samuel Calvin, formerly head of the department of geology at the state university and state geologist, was unveiled and presented by the Academy to the State Historical Department at Des Moines. President Stephens then delivered his address on "The Taxonomic Unit."

After the reading of papers the academy adjourned to see the moving pictures showing the University Barbados-Antigua Expedition of 1918 and also those showing the development of the potato disease known as "Leak" by the fungus *Pythium DeBaryanum*. Owing to the fulness of the program it was necessary to hold a short session after the group dinners, following which President Jessup, of the university, and Mrs. Jessup received the visiting members at their home.

Section meetings were held on Saturday forenoon and at the succeeding business session the following officers were chosen for the coming year: *President*, Nicholas Knight, Cornell College, Mount Vernon; *First Vice-president*, D. W. Morehouse, Drake University, Des Moines; *Second Vice-president*, R. B. Wylie, State University, Iowa City; *Secretary*, James H. Lees, Iowa Geological Survey, Des Moines; *Treasurer*, A. O. Thomas, State University, Iowa City.

The academy ratified the action of its executive committee in accepting affiliation with the American Association for the Advancement of Science, which action had been taken soon after the meeting of the association in St. Louis. The constitution was amended to provide for the collection of dues of the association by the treasurer of the academy at the same time as the academy dues, and also to provide for the beginning of the fiscal year on October 1. Also an amendment was passed providing for the selection by the academy of a representative on the council of the American Association for the Advancement of Science.

The Iowa sections of the American Chemical Society and the Mathematical Association of America held their meetings in conjunction with the academy.

TITLES OF PAPERS

Botany

The treatment of certain seed-carried diseases: GUY WEST WILSON.

This paper deals with work on cotton diseases conducted by the author and associates at the South Carolina Experiment Station. Cotton anthracnose is the most important disease of field crops in the southeastern states, comparing favorably with the wheat rust in the Mississippi valley. The author and his associates have perfected a method of treating the seed which is practicable on a commercial scale and which bids fair to be of considerable value in the treatment of seed carried diseases of other crops.

Some noteworthy uredinales and ustilaginales: GUY WEST WILSON.

Notes on apogamous Liguliflorœ: RAYMOND A. FRENCH.

Some aspects of the plant ecology of certain Kansas sand hills: FRED W. EMERSON.

The sand hills studied lie in south-central Kansas along Arkansas river between Wichita and Hutchinson. Dense vegetation holds the sand stable wherever man permits; burning, close grazing and attempts to plant farm crops have removed natural vegetation from considerable areas not only making them useless but threatening neighboring farm lands with being covered with

blowing sand. All degrees of reclamation by invading vegetation are found. The types and characteristics of the plants are noted and short lists of the more important plants found at the various stages are given.

Notes on some Rocky Mountain plants, chiefly of the Arapahoe mountains: L. H. Pammel and R. I. Cratty.

Further notes on the germination of some trees and shrubs and their juvenile forms: L. H. Pammel and Charlotte M. King.

On the occurrence of the giant puff ball: Harry M. Kelly.

The disintegration of certain intracellular bodies: Clifford H. Farr.

The teaching of plant pathology: W. H. Davis.

Plant tumors: Henry Albert.

The vegetation of Cape Blanco: Morton E. Peck.

The major vegetation of Lake Okoboji: Robert B. Wylie.

Some Alaska fungi: J. P. Anderson.

The genus Ceanothus in Iowa: B. Shimek.

Quercus lyrata Walter in Iowa: B. Shimek.

Seasonal variations in their relation to ecological field observations: B. Shimek.

Notes on the distribution of midsummer bee plants in the Mississippi zone of Clayton county: Ada Hayden.

The growth of foliage leaves: Beryl Taylor.

Comparison of the absorption occurring in corn stalk tissue and in prepared bicolloids: L. E. Yocum and A. L. Bakke.

Mechanical preparation of sweet corn pericarp: R. A. Rudnick and A. L. Bakke.

The Orchidaceæ of Nebraska: T. J. Fitzpatrick.

The influence of forest areas in non-forest regions upon evaporation, soil moisture and movement of ground water: I. Bode.

The paper includes the results of a series of studies carried on in the northeastern part of Iowa during the summer of 1919. The work covers a comparison of the evaporation and soil moisture conditions obtaining on forested and non-forested sites, and the influence that forested areas have as to the checking of runoff, the absorption of moisture in the soil and the response of various soils at various depths to precipitation. The results and conclusions bring out some very interesting facts relative to the economic values of forest areas of a state like Iowa in conserving soil moisture, checking evaporation and regulating the flow of smaller streams throughout the state.

Chemistry

Simplified electrotitration and its use in determining the iodine ion: W. S. Hendrixson.

An examination of rain and snow precipitations: J. E. Trieschmann and Nicholas Knight.

The precipitations covering a period of 8½ months, from October 1, 1918, to June 15, 1919, were examined. The samples were collected in granite pans 20 inches in diameter, on an open spot near the center of the village of Mount Vernon, Iowa. The nitrogen in the free and albuminoid ammonia, nitrates and nitrites was determined. Most of the winter precipitations contained sulphates, probably resulting from the combustion of coal. A few analyses showed a trace of phosphate. All the rain and snow contains a constant amount of chlorine, probably carried in the winds from the Atlantic.

An apparatus for determining solubilities up to the critical temperature: P. A. Bond.

The nitration of halogenated phenols: L. Charles Raiford.

Vacuum tube circuits as a source of power for conductivity measurements: H. A. Geauque.

The free energy of dilution and the activity of the ions of sodium bromide: J. N. Pearre and H. B. Hart

Geology

Iowa terranes compared with those of adjoining states: Charles Keyes.

Since geologic phenomena are not restricted by political boundaries many of the missing leaves of Iowa's earth-history are found clearly imprinted in contiguous states. But it is difficult to make very close comparisons because of the diverse conditions and the varied aims under which the terranal schemes are constructed. By reducing to a standard the geological sections of our state and those of surrounding states a classificatory plan is effected which, although perfectly elastic, permits exact stratigraphic parallelism to be instituted.

Belated survival of Wernerian nomenclature: Charles Keyes.

Galena as denominating a notable Ordovicic dolomite is not a geographic name, as is so often supposed. James Hall, who proposed the term, derived it directly from the chief mineral content of the formation. In using the title this author manifestly modified Featherstonough's earlier name

"Galeniferous Limestone," which in turn was an alteration of Schoolcraft's usage of "Metalliferous Limestone."

Rectification of Iowa's Cambric section: CHARLES KEYES.

Recent critical inspection of the type localities of the Cambric formations of the upper Mississippi basin indicates that there are grave misinterpretations of stratigraphic succession. Thus, some well-known formational titles become synonyms and pass out of use; several names are new; and a number of substitutions appear. Exact parallelism of the upper Mississippi Basin section and that of the Ozarks is thus satisfactorily permitted.

The use of the terms flint and chert: W. S. GLOCK.

Common usage of these terms may leave such an uncertainty that a word dare not be employed where scientific accuracy is desired. For example, it is a common habit to call any form of quartz interbedded with iron ore "chert" for want of knowledge of the nature of the quartz and of the meaning of the term employed. Detailed reference to the standard English and American textbooks on geology and mineralogy substantiates the confusion which exists and which is presented therein for the instruction of the reader. Neither chert nor flint should be a provoking "catch-all"; fundamentally they are good terms whose use is justified only where exactness is implied.

The fauna of the Independence Shale: A. O. THOMAS.

This interesting fauna, first reported by Dr. Calvin over forty years ago from a very limited exposure, has recently become better known due to the discovery of several fossiliferous outcrops of the shale as reported before the academy a year ago. Among the additions to the fauna is a species of the crinoid *Arthracantha*, hitherto known only from the Devonian of the region of Lake Ontario. There is also a species of *Spirifer* akin to *S. disjunctus*, a new *Chonetes*, and a fine specimen of *Hypothyridina cuboides*. A few of the species of the Independence shale recur in the Lime Creek shale at the top of the Iowa Devonian but none of the forms just mentioned are known to occur in the later formation.

Nortonechinus, a Devonian sea urchin: A. O. THOMAS.

This is a highly specialized genus known only from dissociated plates, spines, and parts of the lantern. The test of the living animal was doubtless very flexible and was well protected by the covering afforded by the broadly expanded distal ends of the spines as in modern *Colobocentrotus*. Two other genera of echinoids also found in the Lime Creek shales will be briefly discussed.

The corals of the Hopkinton stage, Iowa Silurian: A. O. THOMAS AND BERYL TAYLOR.

The Iowa Silurian affords a rich and interesting assemblage of corals most of which are highly silicified. The Calvin Collections from the typical localities together with those made by various field classes and by the writers, furnish a large series in which some of the genera are very well represented. *Strombodes*, for example, has no less than ten species, *Favosites*, seven, *Zaphrentis*, six, and *Heliolites*, four. The reefs furnish upwards of seventy species, many of which are new.

The conservation of underground water: JAMES H. LEES.

The paper discusses the importance of water, its source and distribution, its relation to the rock strata and its use by plants. The need for better conservation is emphasized and the effect of population increase and of agriculture is discussed.

Certain post-Pliocene deposits in Missouri: B. SHIMEK.

On the occurrence of charcoal in an interglacial peat bed in Union county: RALPH W. CHANEY.

A sink hole in northeast Iowa: E. J. CABLE.

A note on the progress of investigation of the Iowan-Wisconsin border: E. J. CABLE.

A field of eskers in Iowa: JOHN E. SMITH.

The content of agricultural geology: JOHN E. SMITH.

The Palisades of the Cedar: WM. H. NORTON.

A comparison of the Nebraskan drift with the Kansan drift: GEORGE F. KAY.

Physics

The Hall effect and the specific resistance of thin silver films: G. R. WAIT.

The dependence of the resistance of silver films upon the method of deposition: G. R. WAIT.

On the dynamics of an airplane loop: L. P. SIEG.

A new high frequency tone generator: C. W. HEWLETT.

The perception of binaural phase difference not caused by an intensity effect: G. W. STEWART.

The frequency limits of the binaural phase difference and intensity effects: G. W. STEWART.

Note on the principle of similitude: I. MAIZLISH.

A table of the total number of stroboscopic velocity curves for any of the natural numbers from 1 to 500 inclusive taken as a limiting value of n and m: L. E. Dodd.

On finding the equation of the characteristic blackening curve of a photographic plate: P. S. Helmick.

The overtones of air columns: L. B. Spinney.

The stereoscope in teaching physics and geometry: LeRoy D. Weld.

The stereoscope has usually been considered a mere toy. In this paper, however, is given a method whereby stereoscopic drawings of any simple figure in space can be easily prepared and duplicated for use in the study of any subject requiring three-dimensional figures, such as solid geometry, crystal structure, analytic mechanics, optics, etc.

Psychology

Symposium: Some Results of Current Research in the Psychological Laboratory of the State University. Introduced by C. E. Seashore.

The talent survey in our music school: Esther Allen Gaw.

The Iowa pitch range audiometer: C. C. Bunch.

The normal curve of acuity in hearing: Paul B. Anderson.

The localization of sound by wave phase in the open ear: Henry M. Halverson.

What constitutes voice: Carl I. Erickson.

The application of the Mendelian law to talent in music: Hazel M. Stanton.

The personal equation in motor capacities: Martin L. Reymert.

Serial action as a basic measure of motor capacities: C. F. Hansen.

The measurement of motility in children: Lillian Tow.

The selection of talent for stenography and typing: B. W. Robinson.

A measure of capacity for acquiring skill in coordination of eye and hand: Wilhelmine Koerth.

A standardized measure of motility: Merrill J. Ream.

Zoology

Some Iowa records of Lepidoptera: A. W. Lindsey.

A biological reconnaisance of Okefinokee swamp, Georgia. The fishes: E. L. Palmer and A. H. Wright.

The Okefinokee swamp in its fish fauna is decidedly fluviatile. Like that of Florida its fish fauna may be held to have "originated from the north and is thus not tropical." The swamp has twenty-three less fresh water species than the whole state of Florida and in number of forms is not comparable to the better known Everglades of Florida. Twenty-eight species are known from the swamp and twenty-two of these are included in the collection upon which this paper is based. Sixty-three specimens of the rare *Lucania ommata* (Jordan) were taken. The southern limit of the range of *Umbra limi* (Kirtland) is increased from North Carolina to southern Georgia. In addition the material supports contentions that *Umbra pygmæa* DeKay is a synonym of *Umbra limi* (Kirtland); *Esox vermiculatus* Le Sueur, of *Esox americanus* (Gmelin.); *Enneacanthus gloriosus* (Holbrook), of *Enneacanthus obesus* Baird; and *Copelandellus quiescens* (Jordan), of *Boleichthys fusiformis* Girard.

Bird records of the season 1919–1920 in the vicinity of Iowa City: Dayton Stoner.

Cladocera of the Okoboji and Spirit Lake regions: Frank A. Stromsten.

Copepoda of the Okoboji region: Frank A. Stromsten.

Rotatoria of the Okoboji region: Dwight C. Ensign.

Similarities between the lateral-line systems of elasmobranchs and amphibians: H. W. Norris.

Naked neuromasts in amphibians correspond to pit-organs and canal-organs in the elasmobranch fishes. The mandibular series of neuromasts of amphibians is distinctly double, oral, and gular. Similarly in elasmobranchs the mandibular and hyomandibular canal organs correspond to the oral series and a mandibular row of pit-organs to the gular series of neuromasts of amphibians. The vaguely defined occipital group of neuromasts of amphibians corresponds to the sense-organ of the supratemporal canal. Three lines of neuromasts occur on the trunk of the body in amphibians, innervated by three distinct nerve rami. Three series of lateral-line organs are to be found on the trunk in elasmobranchs.

Susceptible and resistant phases of the dividing sea-urchin egg when subjected to various concentrations of lipoid-soluble substances, especially the higher alcohols: Francis Marsh Baldwin.

When subjected to suitable concentrations of various lipoid-soluble substances the developing sea-urchin egg shows unmistakable rhythms of sus-

ceptible and resistant phases, which fact constitutes additional evidence that a very intimate relation exists between the general physiological condition of the egg, and the physical state of its plasma-membrane. During the first ten to fifteen minutes after fertilization the eggs are more susceptible to all substances tried than at any other time until the period just preceding and during the division process. A period of marked increased susceptibility occurs during the division process which outlasts the furrow formation in most cases about ten to fifteen minutes, and during this interval, marked cytological effects in the eggs are noted. The best records were obtained using i-amyl and capryl alcohols, possibly indicating a higher specific toxicity of these men when compared to the others.

Notes on the branches of the aorta (Arcus aortæ) and the subclavian artery of the rabbit: Francis Marsh Baldwin.

Although the usual number of blood vessels arising from the arch of the aorta in the rabbit is two —a so-called innominate or brachio-cephalic artery and a left subclavian artery—the variations from this condition indicate the possibility of a considerable departure. In a number of cases, three vessels have their origin on the arch and in these the order is the brachio-cephalic, the left common carotid and the left subclavian arteries. Conspicuous differences in the order and sequence of the vessels from the subclavian arteries of the two sides are noted. On the left side the vessels in a number of cases show a tendency to group themselves either proximally or distally in the form of a sort of corona.

A study of the phylogeny of certain hymenopterous parasites of leafhoppers: F. A. Fention.

This paper deals with the *Anteoninæ* (*Dryinidæ*), a small parasitic group now classed with the *Bethylidæ* under the *Proctotrupoidea.* We are now able to trace the evolution of the peculiarly specialized species from the more simple and generalized types. So far as our present knowledge is concerned these insects are parasitic on the leaf- and tree-hoppers and there is an interesting relationship in the evolution of these parasites with their homopterous hosts. The larvæ are mostly externally attached to the host and are incased and protected in the larval exuviæ which form a protective sac. The fore tarsi of the adult parasites in a great many cases are modified into perfect chelæ or clasping organs, a fact not found in any other insect group.

The relative position of the maxima contractions of the Amphibian muscle when subjected to various ranges in temperature: Ralph L. Parker.

The results of a series of twenty experiments upon the gastrocnemius muscles of frogs showed three apparent maxima contractions within the range of plus ten degrees Centigrade through zero degrees to rigor caloris. These varied to some extent as to what degree the maxima fell, depending upon the individual. Rigor caloris of the muscles generally proximated that of the greatest maxima, while that when all were combined and averaged was less than the greatest maxima. Selecting those which recorded in all ranges of temperature and averaging them (seven) the results were nearly parallel to the average of all the muscles and only two maxima contractions appeared. Rigor caloris was greater than the maximum contraction.

A revision of the Cercopidæ of North America north of Mexico: E. D. Ball.

The family Cercopidæ is the smallest and best known of all the groups of the Homoptera. The writer's key to the genera and species of the family published over twenty years ago is now out of date. A number of changes in synonymy and distribution have been made and several species and varieties added and the whole information brought up to date.

A review of the desert leafhoppers of the Orgerini (Rhynchota fulgoridæ): E. D. Ball and Albert Hartzell.

These desert leafhoppers are a group of round, fat, short-winged insects with very peculiar structural modifications probably developed to adapt them to the extremely hot conditions of the deserts. These modifications consist in an elongation of the rostrum or beak and a lengthening of the legs so that the insect walks upright and its body is thus removed from close contact with the hot sands.

These insects are all inhabitants of the arid regions west of the Rockies and are little known. A number of new genera and species are proposed, together with the classification and life histories of the group.

Notes on some dipterous parasites of leafhoppers: I. L. Ressler.

Two new species of Pipunculidæ, of the genus *Pipunculus,* reared from the nymph of the leafhopper *Deltocephalus sayi* Fitch are described and discussed in this paper. The Pipunculidæ are small flies about one eighth of an inch long, the head being larger than the thorax, and consisting chiefly of the large, closely approximated eyes.

While it is known that the larvæ of these flies are parasitic in their habits, very little is known of their host relations.

An intensive ornithological survey of a typical square mile of cultivated prairie: ARTHUR R. ABEL.

Bird records of the past two winters, 1918–1920, in the upper Missouri valley: T. C. STEPHENS.

A study of sociality in the phylum Coelenterata: H. J. WEHMAN AND GERTRUDE VAN WAGENEN.

On the parasites of the unios of the Lake Okoboji region: HARRY M. KELLY.

The 1919 outbreak of armyworms and variegated cutworms in Iowa: H. E. JAQUES.

The pathology of lethargic encephalitis: HENRIETTA CALHOUN.

Descriptive notes concerning the American bald eagle: BEN HUR WILSON.

Some impressions obtained from a review of Professor Nutting's narrative of the Barbados-Antigua expedition: A. C. TROWBRIDGE.

Archeology

The material for a study of Iowa archeology: CHARLES REUBEN KEYES.

The Keokuk type of stone ax: CHARLES REUBEN KEYES.

General

The comparative stability of colors in wallpaper: J. M. LINDLY.

Iowa Section Mathematical Association of America

Note on a generalization of a theorem of Baire: E. W. CHITTENDEN.

A celebrated theorem of Baire states that the necessary and sufficient condition that a function $F(x)$ defined on a closed set P in space of n-dimensions be the limit of a sequence of continuous functions defined on P is that if Q be a perfect subset of P, then $F(x)$ has a point of continuity in every portion, however small, of the set Q. Professor Chittenden calls attention to the fact that a proof of this theorem given by Vallée-Poussin can be extended without difficulty to the case of a set P in an abstract space of a type studied by Fréchet. As a special instance, P may be a perfect set in a compact space of infinitely many dimensions.

Notes on the history of indeterminate equations: R. B. MCCLENON.

Professor McClenon traces the history of some indeterminate equations found in the writings of Leonardo of Pisa, showing the contributions that had been made to their solution by the Hindus and Arabs, as well as their further development by later writers, down to modern times.

A pseudo velocity-resistance graph for low angle firing: M. E. GRABER.

Mayevski's law for air resistance is unsatisfactory because the discontinuities introduced render numerical integration difficult. Professor Graber presents a smooth curve law for the velocity-resistance relation between the velocities of 750 ft./sec. and 1700 ft./sec. and compares it with a pseudo velocity-resistance standardization curve.

What is number? C. W. WESTER.

An attempt to state in a simple way some of the outstanding differences between current definitions of number, especially between what may be called the mathematical and the metaphysical definitions; and to suggest the lines along which a working agreement may be reached as to what shall be thought of as number in elementary mathematics.

The teaching of limits in the high school: J. V. MCKELVEY.

In this paper Professor McKelvey discusses certain popular misconceptions in regard to limits and outlines a point of view from which a rigorous and usable understanding of this seemingly bewildering subject may be obtained. No plea is made either for or against the teaching of limits in preparatory schools.

The taxonomy of algebraic surfaces: R. P. BAKER.

The integration of the indefinite integral in the first course: W. H. WILSON.

A problem in summation of series: JOHN F. REILLY.

A geometric construction for the regular 17-gon: LINN SMITH.

JAMES H. LEES,
Secretary

DES MOINES, IA.

SCIENCE

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